IRON AND STEEL INSTITUTE

ADDRESS OF THE PRESIDENT, C. WILLIAM SIEMENS, D.C.L., F.R.S.

THE Iron and Steel Institute opened its London Session on Tuesday, and yesterday Dr. C. W. Siemens gave his presidential address.

Dr. Siemens, after referring to the origin and progress of the Institute, touched upon several topics of interest to those connected with the iron and steel industries.

Speaking of Education, Dr. Siemens said :—Intimately connected with the interests of this institution, and with the prosperity of the iron trade, is the subject of technical education. It is not many years since practical knowledge was regarded as the one thing requisite in an iron smelter, whilst theoretical knowledge of the chemical and mechanical principles involved in the operations was viewed with considerable suspicion. The aversion to scientific reasoning upon metallurgical processes extended even to the authors who protessed to enlighten us upon these subjects ; and we find, in technological works of the early part of the present century, little more than eye-witness accounts of the processes pursued by the operating smelter, and no attempt to reconcile those operations with scientific facts. A great step in advance was made in this country by Dr. Percy, when, in 1864, he published his remarkable "Metallurgy of Iron and Steel." Here we find the gradual processes of iron smelting passed in review, and supported by chemical analyses of the fuel, ores, and fluxing materials employed, and of the metal, slags, and cinder produced in the operation. On the continent of Europe the researches of Ebelmann, and the technological writings of Karsten, Tunner, Gruner, Karl, Akermann, and others, have also contributed largely towards a more rational conception of the processes employed in iron smelting.

It must be conceded to the nations of the Continent of Europe that they were the first to recognise the necessity of technical education, and it has been chiefly in consequence of their increasing competition with the producers of this country, that the attention of the latter has been forcibly drawn to this subject. The only special educational establishment for the metallurgist of Great Britain is the School of Mines. This institution has unquestionably already produced most excellent results in furnishing us with young metallurgists, qualified to make good careers for themselves, and to advance the practical processes of iron making. But it is equally evident that that institution is still susceptible of great improvement, by adding to the branches of knowledge now taught at Jermyn Street, and I cannot help thinking that a step in the wrong direction has recently been made in separating geographically and administratively the instruction in pure chemistry from that in applied chemistry, geology, and mineralogy. If properly supported, the School of Mines might become one of the best and largest institutions of its kind, but it would be an error to suppose that, however successful it might be, it could be made to suffice for the requirements of the whole country. Other similar institutions will have to be opened in provincial centres, and we have an excellent example set us by the town of Manchester, which, in creating its Owens College, has laid the foundation for a technical university, capable of imparting useful knowledge to the technologist of the future.

Technical education is here spoken of in contradistinction to the purely classic and scientific education of the Universities, but it must not be supposed that I would advocate any attempt at comprising in its curriculum a practical working of the processes which the student would have to direct in after-life. This has been attempted at many of the polytechnic schools of the Continent with results decidedly unfavourable to the useful career of the student. The practice taught in such establishments is devoid of the commercial element, and must of necessity be an objectionable practice, engendering conceit in the mind of the student, which will stand in the way of the unbiassed application of his mind to real work. Let technical schools confine themselves to the teaching of those natural sciences which bear upon practice, but let practice itself be taught in the workshop and in the metallurgical works.

After referring to the question of Labour, Dr. Siemens spoke in some detail on that of Fuel. Fuel, in the widest acceptation of the word, may be said to comprise all potential force which we may call into requisition for effecting our purposes of heating and working the materials with which we have to deal, although in a more restricted sense it comprises only those carbonaceous matters which, in their combustion, yield the heat necessary for working our furnaces, and for raising steam in our boilers.

The form of fuel which possesses the greatest interest for us, the iron smelters of Great Britain of the nineteenth century, is without doubt the accumulation of the solar energy of former ages which is embodied in the form of coal, and it behoves us to inquire what are the stores of this most convenient form of fuel.

Recent inquiry into the distribution of coal in this and other countries has proved that the stores of these invaluable deposits are greater than had at one time been supposed.

I have compiled a table of the coal areas and production of the globe, the figures in which are collected from various sources. It is far from being complete, but will serve us for purposes of comparison.

The Coal Areas and Annual Coal Production of the Globe.

	Area in Square Miles	Production in 1874 Tons.
Great Britain	11,900	125,070,000
Germany	1,800	46,658,000
United States	192,000	50,000,000
France	1,800	17,060,000
Belgium	900	14,670,000
Austria	1,800	12,280,000
Russia	11,000	1,392,000
Nova Scotia	18,000	1,052,000
Spain	3,000	580,000
Other Countries	28,000	5,000,000
	270,200	274,262,000

This table shows that, roughly, the total area of the discovered coal fields of the world amounts to 270,000 square miles.

It also appears that the total coal deposits of Great Britian compare favourably with those of other European countries ; but that both in the United States and in British North America, there exist deposits of extraordinary magnitude, which seem to promise a great future for the New World.

According to the report of the Coal Commissioners, published in 1871, there were then 90,207 million tons of coal available in Great Britain, at depths not greater than 4,000 feet, and in seams not less than 1 foot thick, besides a quantity of concealed coal estimated at 56,273 millions of tons, making a total of 146,480 millions. Since that period, there have been raised 600 millions of tons up to the close of 1875, leaving 145,880 millions of tons, which at the present rate of consumption of nearly 132 millions of tons annually, would last 1,100 years. Statistics show that during the last 20 years there has been a mean annual increase in output of about 3⅓ millions of tons, and a calculation made at this rate of increase would give 250 years as the life of our coalfields.

In comparing, however, the above rate of increase with that of population and manufactures, it will be found that the additional coal consumption has not nearly kept pace with the increased demand for the effects of heat, the difference being ascribable to the introduction of economical processes in the application of fuel. In the case of the production of power, the economy effected within the last 20 years exceeds 50 per cent., and a still greater saving has probably been realised in the production of iron and steel within the same period, as may be gathered from the fact that a ton of steel rails can now be produced from the ore with an expenditure not exceeding 50 cwt. of raw coal, whereas a ton of iron rails, 20 years ago, involved an expenditure exceeding 100 cwt. According to Dr. Percy, one large works consumed, in 1859, from 5 to 6 tons of coal per ton of rails. Statistics are unfortunately wanting to guide us respecting these important questions.

Considering the large margin for further improvement regarding almost every application of fuel which can be shown upon theoretical grounds to exist, it seems not unreasonable to conclude that the ratio of increase of population and of output of manufactured goods will be nearly balanced, for many years to come, by the further introduction of economical processes, and that our annual production of coal will remain substantially the same within that period, which under those circumstances will probably be a period of comparatively cheap coal.

The above-mentioned speculation leads to the further conclusion that our coal supply at a workable depth will last for a period far exceeding the shorter estimated period of 250 years, especially if we take into account the probability of fresh discoveries, of which we have had recent instances, particularly in

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North Staffordshire, where a large area of coal and blackband ironstone is being opened up, under the auspices of his Grace the Duke of Sutherland, by our member, Mr. Homer.

Dr. Siemens then spoke of Anthracite and the large extent to which it was used in America, of Lignite and Peat, which may be looked on as coal in formation. After referring to natural gaseous fuel he went on to say :—

Although the use of natural gas is not likely to assume very large proportions owing to its rare occurrence, its application at Pittsburg has forcibly reminded me of a project I had occasion to put forward a good many years ago, namely to erect gas producers at the bottom of coal mines, and by the conversion of solid into gaseous fuel, to save entirely the labour of raising and carrying the latter to its destination. The gaseous fuel, in ascending from the bottom of the mine to the bank, would acquire in its ascent (owing to its temperature and low specific gravity), an onward pressure sufficient to propel it through pipes or culverts to a considerable distance, and it would be possible in this way to supply townships with heating gas, not only for use in factories, but, to a great extent, for domestic purposes also. In 1869, a company, in which I took a leading interest, was formed at Birmingham, under the sanction of the Town Council, to supply the town of Birmingham with heating gas at the rate of 6*d*. per 1,000 cubic feet, but their object was defeated by the existing gas companies, who opposed their bill in Parliament upon the ground that it would interfere with vested interests. I am still satisfied, however, that such a plan could be carried out with great advantage to the public ; and although I am no longer specifically interested in the matter, I would gladly lend my aid to those who might be willing to realise the same.

With reference to water power, Dr. Siemens said :—The advantage of utilising water power applies chiefly to continental countries, with large elevated plateaus, such as Sweden and the United States of North America, and it is interesting to contemplate the magnitude of power which is now for the most part lost, but which may be, sooner or later, called into requisition.

Take the Falls of Niagara as a familiar example. The amount of water passing over this fall has been estimated at 100 millions of tons per hour, and its perpendicular descent may be taken at 150 feet, without counting the rapids, which represent a further fall of 150 feet, making a total of 300 feet between lake and lake. But the force represented by the principal fall alone amounts to 16,800,000 horse-power, an amount which, if it had to be produced by steam, would necessitate an expenditure of not less than 266,000,000 tons of coal per annum, taking the consumption of coal at 4 lbs. per horse-power per hour. In other words, all the coal raised throughout the world would barely suffice to produce the amount of power that continually runs to waste at this one great fall. It would not be difficult, indeed, to realise a large proportion of the power so wasted, by means of turbines and water-wheels erected on the shores of the deep river below the falls, supplying them from canals cut along the edges. But it would be impossible to utilise the power on the spot, the district being devoid of mineral wealth, or other natural inducements for the establishment of factories. In order practically to render available the force of falling water at this and the thousands of other places under analogous conditions, we must devise a practicable means of carrying the power to a distance. Sir William Armstrong has taught us how to carry and utilise water power at a distance, if conveyed through high-pressure mains, and at Schaffhausen, in Switzerland, as well as at some other places on the Continent, it is conveyed by means of quick-working steel ropes passing over large pulleys. By these means, power may be carried to a distance of one or two miles without difficulty. Time will probably reveal to us effectual means of carrying power to great distances, but I cannot refrain from alluding to one which is, in my opinion, worthy of consideration, namely, the electrical conductor. Suppose water power to be employed to give motion to a dynamo-electrical machine—a very powerful electrical current is the result. This may be carried to a great distance, through a large metallic conductor, and there be made to impart motion to electro-magnetic engines to ignite the carbon points of electric lamps, or to effect the separation of metals from their combinations. A copper rod of 3 in. in diameter would be capable of transmitting 1,000 horse-power a distance of say 30 miles, an amount sufficient to supply one quarter of a million candle power which would suffice to illuminate a moderately sized town.

The use of electrical power has sometimes been suggested as a substitute for steam power, but it should be borne in mind that so long as the electric power depends upon a galvanic battery, it must be much more costly than steam power, inasmuch as the combustible consumed in the battery is zinc, a substance necessarily much more expensive than coal ; but this question assumes a totally different aspect if in the production of the electric current a natural force is used which could not otherwise be rendered available.

Dr. Siemens then went on to speak of the processes of manufacture, sketching briefly the history of the improvements in these processes, and concluded by referring to the various applications of steel. Speaking of the means of preserving iron and steel from rust, he referred to Prof. Barff's recently discovered process. This consists in exposing the metallic surfaces, while heated to redness, to the action of superheated steam, thus producing upon their surface the magnetic oxide of iron, which, unlike common rust, possesses the characteristic of permanency, and adheres closely to the metallic surface below. In this respect it is analogous to zinc oxide adhering to and protecting metallic zinc, with this further advantage in its favour, that the magnetic oxide is practically insoluble in sea water and other weak saline solutions.

Dr. Siemens concluded his valuable address by urging upon the Institute, now that it has attained to such importance, to obtain recognition in official quarters and to become possessed of a habitation in a central position, and in such a building as would serve the societies devoted to applied science in the same way that Burlington House does those devoted to pure science.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, March 8.—Mr. C. W. Merrifield, F.R.S., vice-president, in the chair.—The following communications were made :—On a new view of the Pascal hexagram, by Mr. T. Cotterill. In a system of co-planar points, the number of intersections of two chords is a multiple of 3. In the case of the hexagram the forty-five points thus derived are divided into four sets of triangles—(1) The three intersections of the chords joining four points form a triad self-conjugate to the conics through the four points. (2) Any three non-conterminous chords intersect in three points, forming a diagonal triangle. In each of these two cases, a derived point determines uniquely its corresponding triad, the number of triads being fifteen. (3) An inscribed triangle determines an opposite inscribed triangle ; the three intersections of the pairs of sides supposed to correspond form a triangle, the intersections of two inscribed triangles, the nine intersections of the two triangles forming an ennead. (4) The three intersections of the opposite sides of a hexagon of the system form a Pascal triangle. The number of triangles in each of the two last cases is sixty ; to each triangle of one set corresponding a triangle of the other, as well as a triad of the second set, the nine points forming three triads of the first set. Denoting, then, the primitive points by italics and fifteen of the derived points (no two of which are conjugate) by Greek letters, we obtain all the derived points by accenting once and twice the Greek letters to form self-conjugate triads. Tables are then formed in matrices of the nine chords joining the vertices of two opposite triangles and their eighteen intersections, found to consist of six triangles of each of the second and fourth sets. To these corresponds a matrix containing the nine intersections of the two triangles. In the case of a conic hexagram, the properties of the sixty points of intersection of chords with the tangents at the conic points are then examined.—On a class of integers expressible as the sum of two integral squares, by Mr. T. Muir. [The class of integers considered included those whose square root, when expressed as a continued fraction, has two middle terms in the cycle of partial denominators. A general expression was given for all such integers, and an equivalent expression in the form of the sum of two squares.]—Some properties of the double-theta functions, by Prof. Cayley, F.R.S. (founded on papers by Goepel and Rosenhain).—A property of an envelope, by Mr. J. J. Walker.

Chemical Society, March 15.—Prof. Abel, F.R.S., president, in the chair.—The secretary read a paper by Dr. W. A. Tilden and Mr. W. A. Shenstone, on isomeric nitroso terpenes, being a further contribution to Dr. Tilden's previous researches on these compounds. This was followed by a communication

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